

APPRAISAL REPORT
Lincoln, New Hampshire
Pemigewasset River

Local Flood Protection Project

July 1990



**US Army Corps
of Engineers**
New England Division

SYLLABUS

This Appraisal Report was prepared for the existing Local Flood Protection Project in the town of Lincoln, New Hampshire under the authority derived from Engineering Regulation, ER 1165-2-119.

This report assesses and documents the adequacy of the LPP in Lincoln, New Hampshire along the East branch of the Pemigewasset River. In addition, this document reports upon the study process used in considering modifications to the LPP as reviewed from the standpoints of economics, environmental, and engineering integrity and safety considerations.

Study efforts have attempted to determine the need for modification of the LPP. It has been concluded that modification to increase the level of protection or extent of the flood control protection is not currently recommended and any further study is not recommended at this time. However, due to the age of the LPP another review should be scheduled. The year 2000 will be an appropriate time for the next review since the LPP will be 40 years old then.

**APPRAISAL REPORT
LOCAL FLOOD PROTECTION PROJECT
Lincoln, New Hampshire**

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I. INTRODUCTION

A. Authority

This Appraisal Report concerns an existing Local Flood Protection Project (LPP) in the Town of Lincoln, New Hampshire. It was accomplished under the authority derived from Engineering Regulations, ER 1165-2-119 which provides guidance direction to the Corps of Engineers to review the adequacy of completed LPP's. The regulation permits the Corps of Engineers to review existing Corps' projects in order to ascertain whether they continue to function in a satisfactory manner and whether the potential exists for better serving the public interest.

B. Background

The Lincoln Local Protection Project consists of 1350 linear feet (ft.) of channel excavation, 230 ft. of flank dike, and restoration of approximately 1400 ft. of the old Franconia Paper Mill flank dike. The construction of the repair and restoration of the existing flood control dike at Lincoln, New Hampshire, was authorized by the Chief of Engineers on March 16, 1960 pursuant to the authority under the Flood Control Act approved August 18, 1941, as amended (Public Law 99, 84th Congress, approved June 23, 1955.)

C. Purpose and Scope

The purpose of this appraisal report is to assess and document the adequacy of the existing LPP at Lincoln, New Hampshire along the East Branch of the Pemigewasset River, and to determine if modifications are advisable and warrant further Federal Study.

Development in watershed areas and new information on basin hydrology since the project's construction may warrant an updated analysis of the level of protection being realized. If changes in a completed project may be desirable, investigations will be undertaken to document the need for and the feasibility of project modification. The objective of this investigation is to determine whether it is advisable to modify the project due to changes in the area being protected, or to make changes to the existing project to improve its viability, safety and reliability.

This document reports upon the study process used in considering modifications to LPP's based on economic, environmental, engineering integrity, and safety considerations.

The detail of this study is strictly at the level of an appraisal. A more detailed reconnaissance study will be required should change to the LPP be pursued. Furthermore, if warranted, a feasibility phase effort would follow, detailing the actual modification alternatives and recommend particular courses of action. The feasibility phase will require cost sharing.

The scope of this report is of a reconnaissance nature. The objectives are:

- **Compilation of existing information.**
- **Determining the need for modification.**
- **Identifying modification opportunities.**
- **Determining preliminary feasibility of modifications.**
- **Recommending future course(s) of action.**

D. Public Coordination

On 6 November 1989, personnel from the New England Division (NED) visited the project and the area being protected. Discussions with the town manager and town planner were held regarding any future plans for the areas currently afforded flood protection.

II. EXISTING CONDITIONS

A. Project Area

1. Description:

The Town of Lincoln, Grafton County, New Hampshire is located in northwestern New Hampshire, approximately 80 miles north of Concord, New Hampshire and 150 miles northwest of Boston, Massachusetts (See Plate 1).

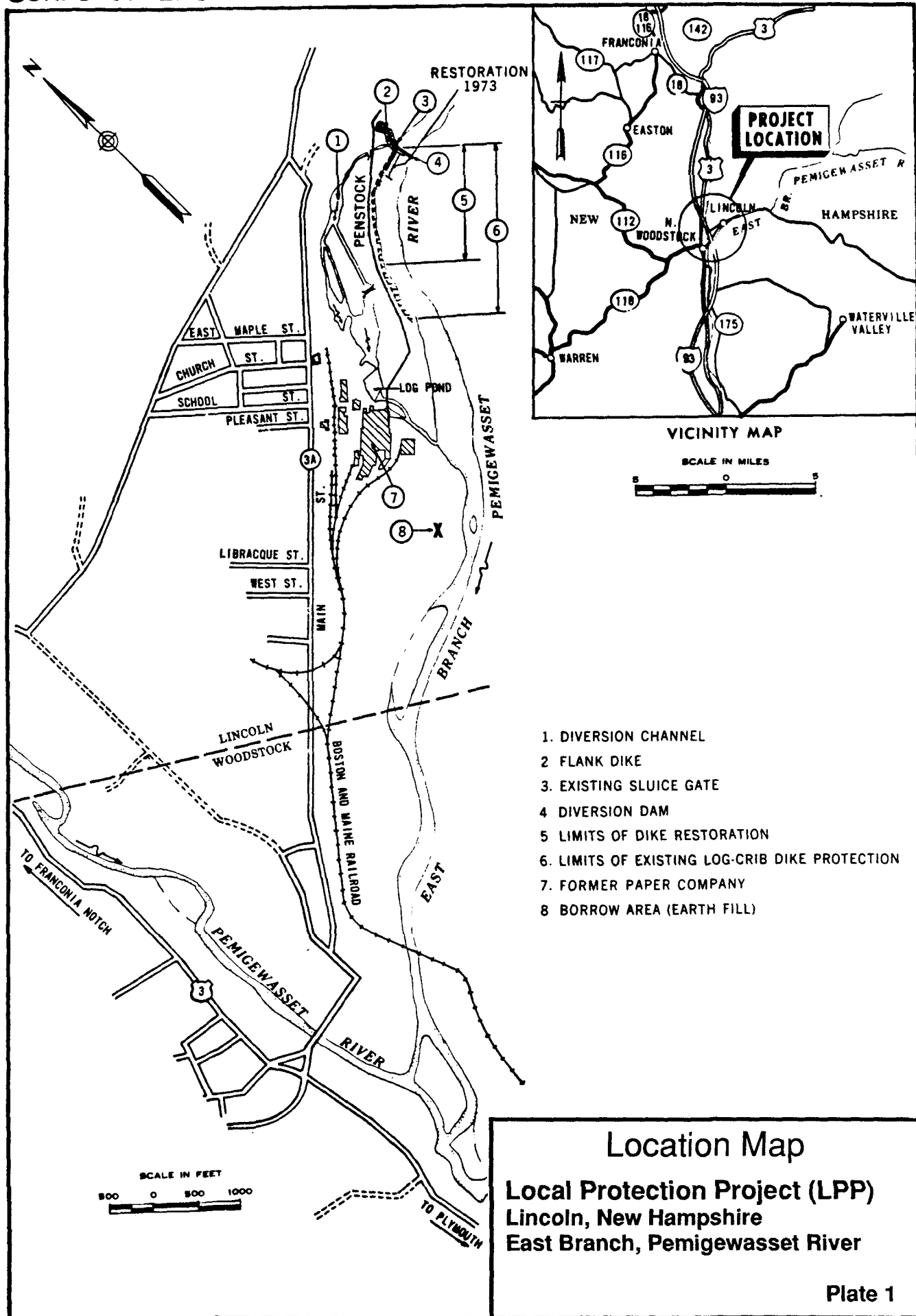
The project location is in the Town of Lincoln, New Hampshire on the East Branch of the Pemigewasset River along its right bank. The East Branch of the Pemigewasset River joins with the Pemigewasset River in North Woodstock, New Hampshire approximately one mile southwest of Lincoln and 170 miles upstream of the mouth of the Merrimack River.

The Town of Lincoln currently has a year-round population of 1443, and increases to approximately 15,000 on weekends in the peak summer and winter tourist and ski seasons. Located in the White Mountain region of New Hampshire, Lincoln and the surrounding areas provide many attractions to both winter and summer visitors. With its numerous restaurants, hotels, condominiums and shops, Lincoln's economy is primarily based on the service industries which support the tourist and ski industries.

2. Current Land Use:

A visit to the town's flood plains and flood protected areas along the East Branch of the Pemigewasset River revealed that there has been significant development since the project was completed in 1960. After changing ownership and opening and closing several times, the paper mill (the original project justification) closed in the early 1970's for economic reasons not related to flooding problems. Subsequently, the paper mill was demolished.

The Town of Lincoln has established two land use zones, general and residential. Currently, all of the land on both sides of the river near the project and surrounding the project is zoned for general use. Much of the land protected by the LPP is currently owned by private developers. Recent developments include condominiums, hotels, shopping plazas and restaurants which are supported by the tourist and recreation industries.



The land immediately adjacent to the LPP contains a new 16 unit condominium project. Additional units are planned for the project, but construction has been delayed because of the current slow real estate market.

The land downstream of the LPP, between the site of the old paper mill, and the project, now contains hotels, condominiums, restaurants and shops. Most of this development is relatively new, built within the last ten years, and most is aimed at the up-scale market. At the site of the former paper mill, there is a several story mall containing shops and restaurants. An old mill building is currently being used as warehouse space and an arts center. The land across the river from the project is undeveloped at the present time.

Although there has been a great deal of development in the area especially in condominiums, according to the town planner, developers have not expressed any concern with flooding in the area.

3. Hydrology and Hydraulics:

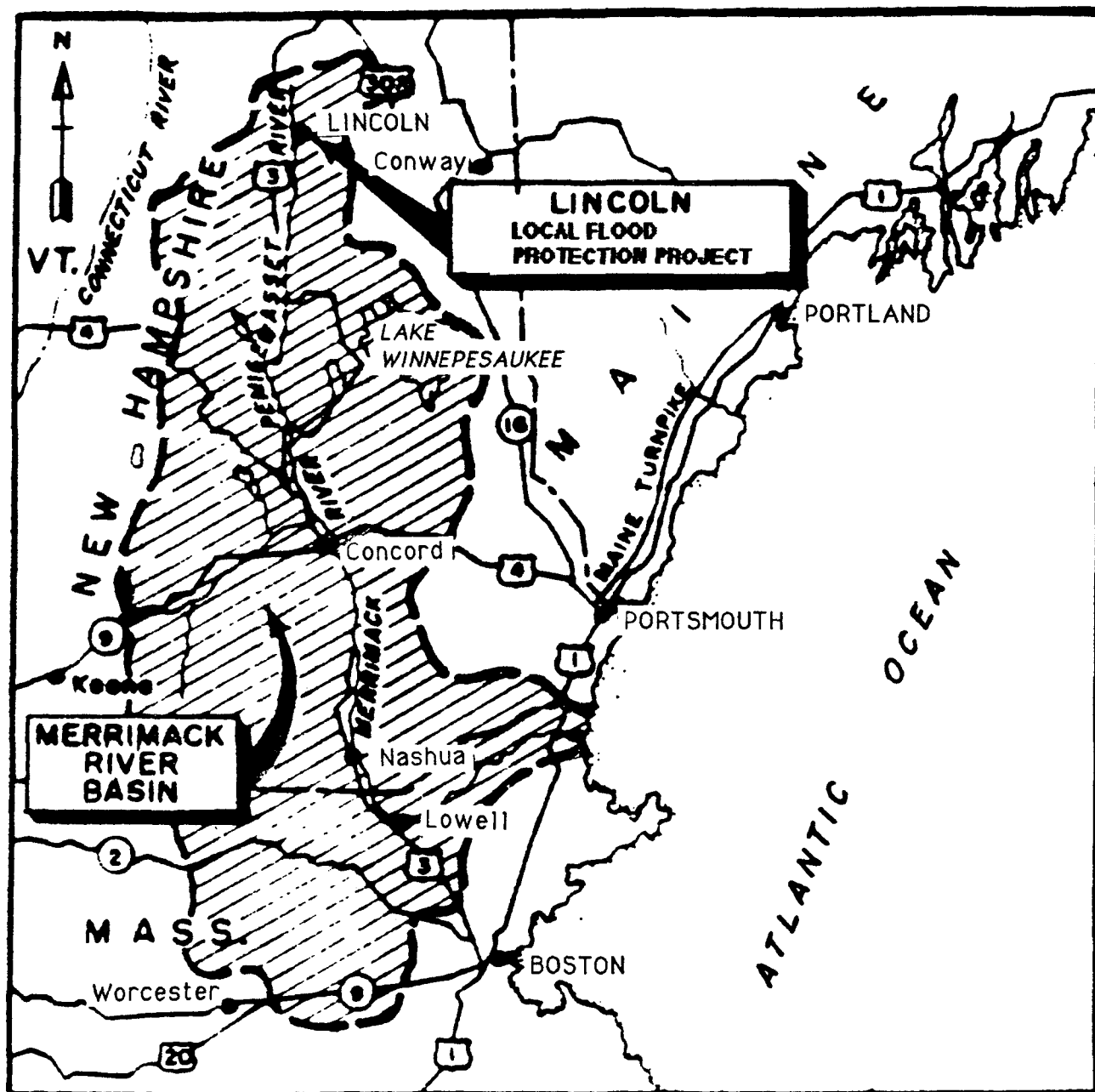
Lincoln, New Hampshire is situated in the upper watershed of the Merrimack River Basin, 80 miles north of Concord, New Hampshire and 150 miles northwest of Boston, Massachusetts. The East Branch of the Pemigewasset River (drainage area of 115 square miles) joins with the Pemigewasset River (drainage area 193 square miles) in North Woodstock one mile from Lincoln, New Hampshire, about 170 miles upstream of the mouth of the Merrimack River. A map of the Merrimack River Basin is shown on the Vicinity Map.(See Plate 1A.)

The Pemigewasset River Basin has a variable climate characterized by frequent but generally short periods of heavy precipitation. The basin lies in the path of the "prevailing westerlies" and is exposed to the cyclonic disturbances that cross the country from west or southwest toward the east or northeast. The area is also subject to coastal storms that travel up the Atlantic seaboard in the form of hurricanes of tropical origin or storms of extra tropical nature, often called "northeasters".

The winters are moderately severe with sub-zero temperatures common. The spring melting of the winter snow cover occurs generally in the months of April and May. The average annual temperature of the area is about 43°F. The summers are rather warm with extreme temperature readings of about 100°F.

The project is located in the White Mountains section of New England with elevations from 2,000 to over 4000 ft. dominating the topography. The mountains have steep grades covered with timber lands with many large brooks and streams discharging high speed erosive type flows into the river.

Discharge records for the East Branch of the Pemigewasset River near Lincoln, New Hampshire (D.A. 109 sq. mi.) have been published by the U.S. Geological Survey for the period of record 1928 thru 1953 and 1968 thru 1972, plus an estimated discharge for the October 1959 flood of record. The gaging station was temporarily abandoned after the March 1953 flood due to destruction of the hydraulic control. Discharge records have also been published for the Pemigewasset River at Woodstock, New Hampshire, drainage area 193 square miles, from October 1939 to date. This gaging station is about 4.3 miles below the confluence with the East Branch.



SCALE IN MILES
0 0 10 20 30 40 50

Vicinity Map
Local Protection Project (LPP)
Lincoln, New Hampshire
East Branch, Pemigewasset River

3. History of Floods:

The East Branch of the Pemigewasset River has experienced eleven major floods in 60 years. A summary of these floods and their peak discharges are shown in Appendix A, Table 1. The two largest floods occurred in October 1959 and November 1927. The flood of 24 October 1959 was estimated by the USGS as having an instantaneous peak of 24,200 cfs at the diversion dam located immediately upstream of the project area. The peak discharge during the flood of November 1927 is unknown but is reported by local residents to have been the largest flood prior to October 1959. Hydrologic analysis of the two floods in the upper Pemigewasset River indicated that the peak flow on the East Branch during the October 1959 flood was probably slightly in excess of that during the November 1927 flood. No overtopping of the dike has been reported since the construction of the LPP.

B. Project Description

1. History:

The Lincoln LPP is located in northwestern New Hampshire on the East Branch of the Pemigewasset River in the Town of Lincoln and extends from the former Diversion Dam of the Franconia Paper Company for a distance downstream of approximately 1450 ft. along the right bank of the East Branch of the Pemigewasset. Construction of the Lincoln LPP was initiated in July 1960 and was completed in December 1960.

The Lincoln LPP was constructed to restore an existing timber crib flood control dike that was damaged during the October 23-25 1959 flood. The timber crib dike was originally constructed following the 1936 flood by the Franconia Paper Company.

The paper company was located on the right bank of the East Branch about 1 1/2 miles upstream of the Pemigewasset River. The Franconia Paper Company was the successor to the Parker Young Company which suffered severe losses in the 1927 flood and substantial losses during the 1936 flood which contributed to financial difficulties resulting in bankruptcy.

The Franconia Paper Company constructed approximately 2,000 linear feet of log crib dike along the right bank of the river which was buried with stone. The crib dike acted as a deflecting shield, preventing rushing waters from flanking the right bank, entering a log pond upstream of the mill, and demolishing the mill itself. The protective works extended for approximately 2,000 feet downstream from a low diversion dam located 1/2 mile upstream of the mill. About 1-3/4 miles upstream from the mill was the site of #1 dam, used primarily as a power dam which housed equipment for a penstock that ran for 9,500 linear feet into generating rooms of the mill. Both the diversion dam and #1 dam were of minimal value as flood retention reservoirs.

According to plant officials of the Franconia Paper Company, the Flood of 24 October 1959 was as severe as any previously experienced. The Mill itself escaped serious damage because of the log-crib dike protection. The Flood, however, had caused serious erosion to this protective shield and it was of primary concern to plant officials who fear that even minor flooding would cause it's failure and thereby imperil plant operations.

The Franconia Paper Company was highly susceptible to flood damages from larger floods without the dike restoration. In a major flood without the dike, the mill would be closed for several months for extensive repairs resulting in the loss of purchasing power for the 600 full-time plant workers and 300 part-time woodsmen. Since the Franconia Paper Company was the primary employer, representing the livelihood of Lincoln and the surrounding area, including N. Woodstock and Plymouth, a mill closure would in turn create a significant economic burden for the area. It was determined in the Letter Design Memorandum that construction of the repair and restoration of the flood control dike, the Lincoln LPP would be economically justified.

Major project features include 1350 ft. of channel excavation, 230 ft. of new flank dike and approximately 1400 ft. of existing dike restoration including 3 to 5 ton cover stone placed on a slope of 1 vertical on 2 horizontal. (See Plate 2 and Plate 3.) Lincoln LPP's first cost in 1960 was \$140,000. This included items of local cooperation (lands, easements, right-of-way, emergency repairs, etc.) amounting to \$20,000. The LPP was designed to provide complete protection for flood flows of up to 24,200 cfs This corresponds to the record flood of October 1959.

2. Damages Prevented:

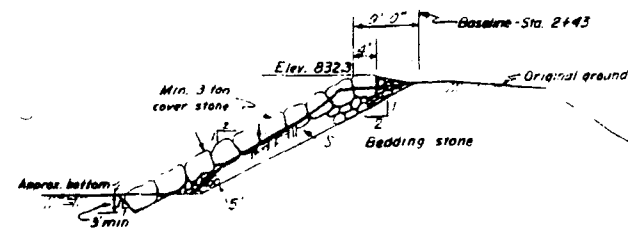
The Lincoln LPP was constructed to prevent flood waters from overflowing the right bank of the East Branch of the Pemigewasset River, entering a log pond upstream of the former mill, and causing extensive damage to the mill itself. The economic benefits attributable to the LPP are equal to the flood damages prevented. Based on a flood damage survey conducted by the Corps of Engineers and hydrologic data gathered, it was estimated in 1960 that the LPP would provide protection to the Franconia Paper Company against a 100 year flood event and prevent damages from a 100 year event of \$1,000,000 in 1960 dollars. Average annual benefits to the LPP were \$17,000 (1960 dollars), which compared to average annual costs of \$5,500 (1960 dollars) yields a benefit to cost ratio of 3.1 to 1.

3. Level of Protection:

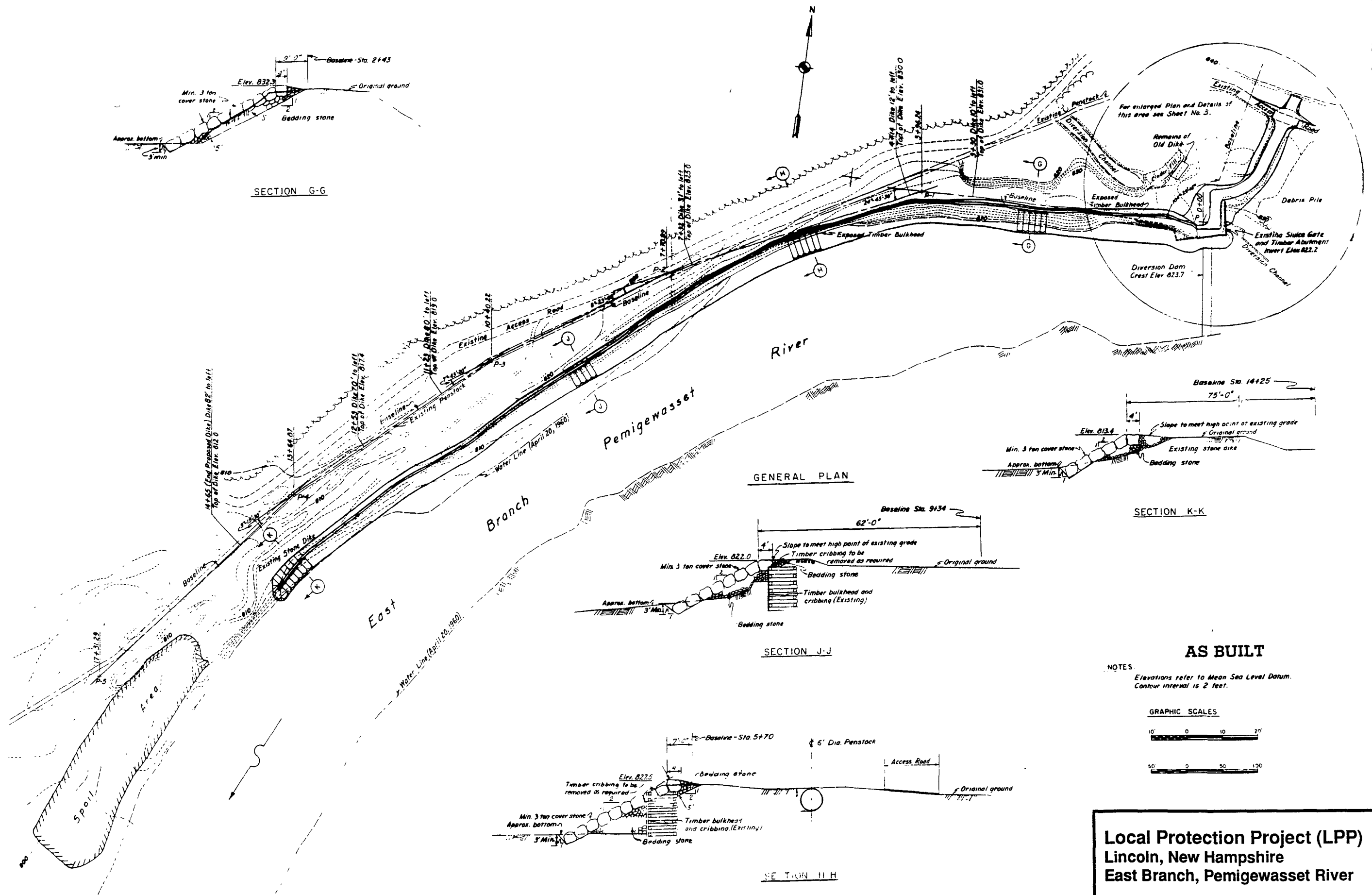
The October 1959 flood (an estimated 100 year event) was the adopted design flood for the LPP. A flow of 24,200 cfs was originally estimated to have about one percent (100 year) annual chance of occurrence. The water surface profile of this flood along the right bank closely paralleled the top of the existing dike constructed by the Franconia Paper Company. It was determined that a reasonably high degree of protection could be provided by restoring the existing dike to the record flood level plus 3 ft. of freeboard. Although not used for the project design, the magnitude of a standard project flood (SPF) was roughly determined to indicate the potential of the area. It was estimated that a standard project flood at the project site would likely exceed 50,000 cfs. However, because of the character and magnitude of the project, the October 1959 flood was the adopted design flood.

4. Recent Inspection:

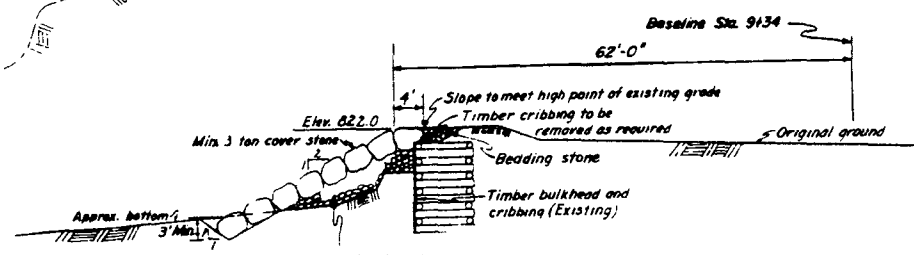
The most recent semi-annual inspection by the Corps for the Lincoln LPP was conducted on 24 April 1989. The project is in satisfactory condition, capable of fulfilling its intended purpose. Although , the Franconia Paper Mill is no longer present, the project provides protection for structures in the protected area. However, it was noted that annual brush cutting is needed each year. In addition, the town needs to be reminded that they are still responsible for the LPP. The most recent inspection report is shown in **Appendix B**.



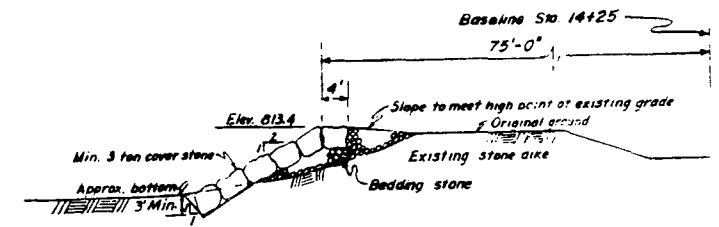
SECTION G-G



GENERAL PLAN



SECTION J-J



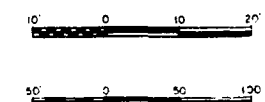
SECTION K-K

AS BUILT

NOTES

Elevations refer to Mean Sea Level Datum.
Contour interval is 2 feet.

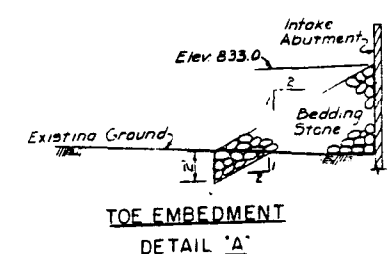
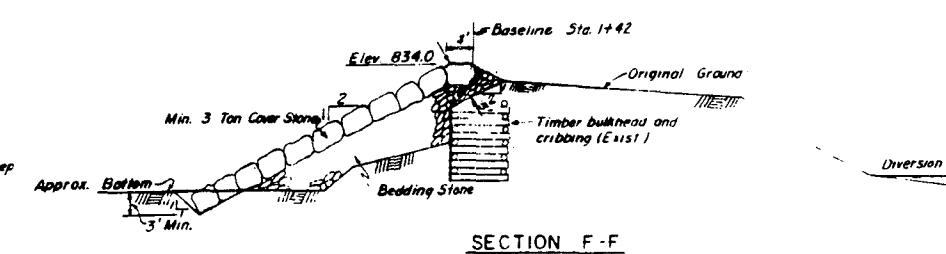
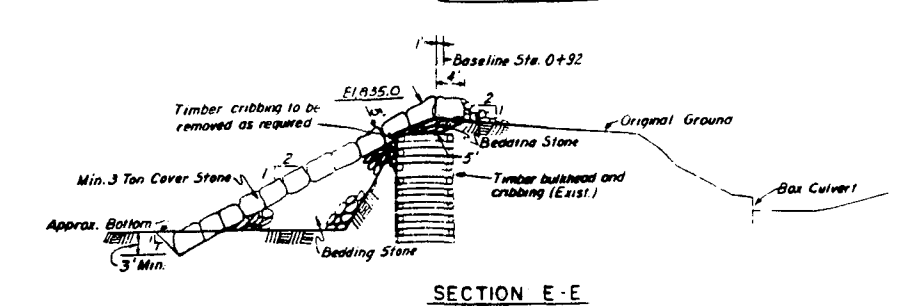
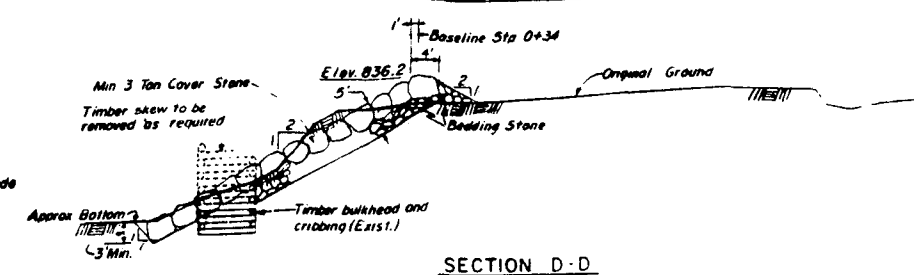
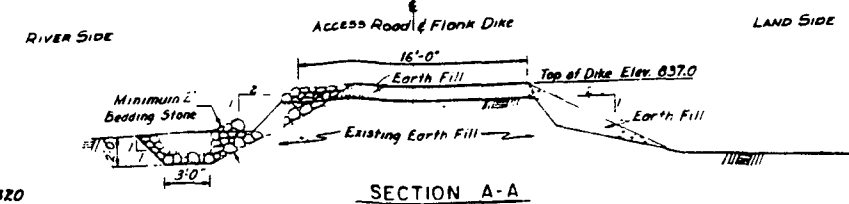
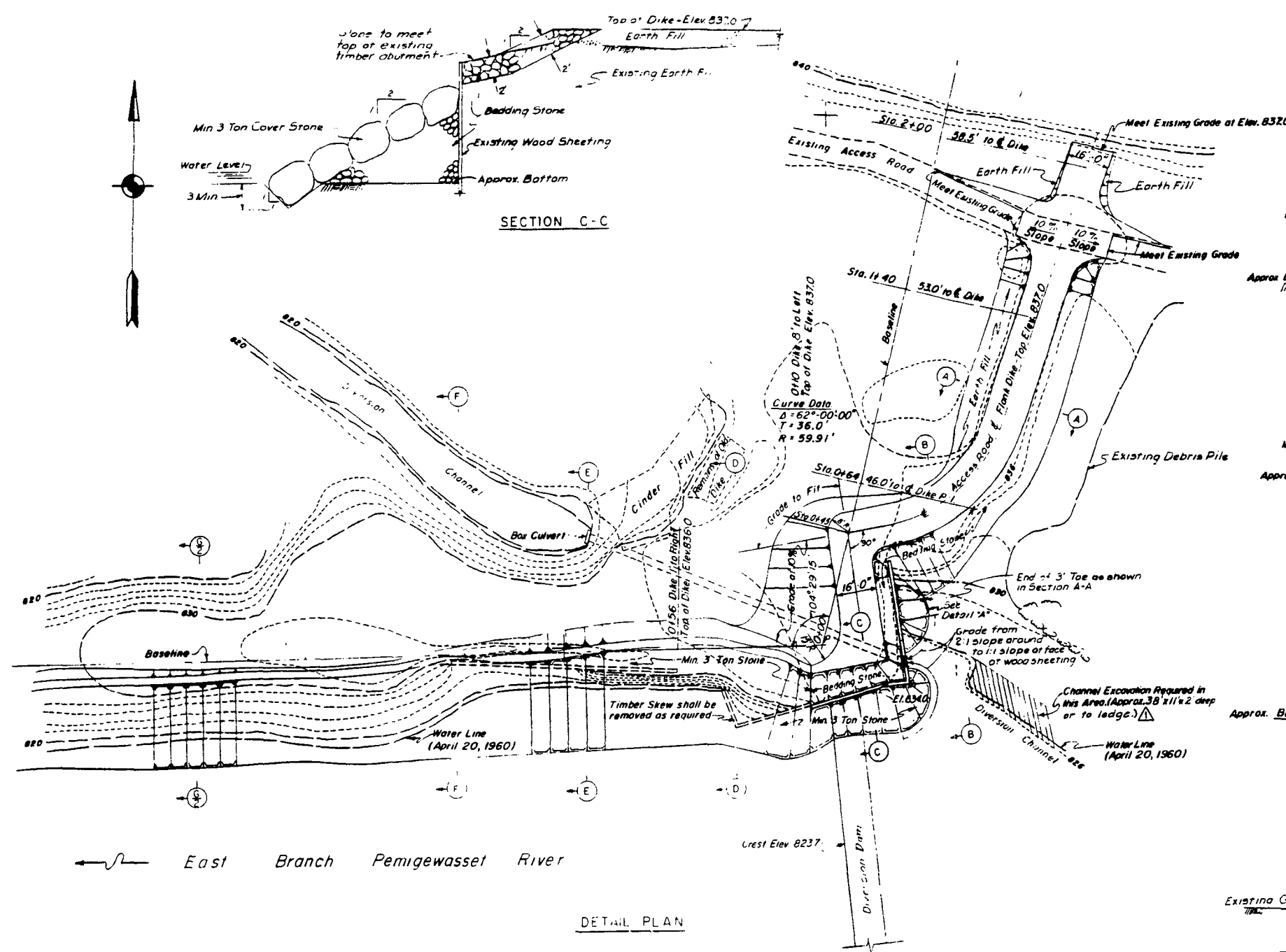
GRAPHIC SCALES



Local Protection Project (LPP)
Lincoln, New Hampshire
East Branch, Pemigewasset River

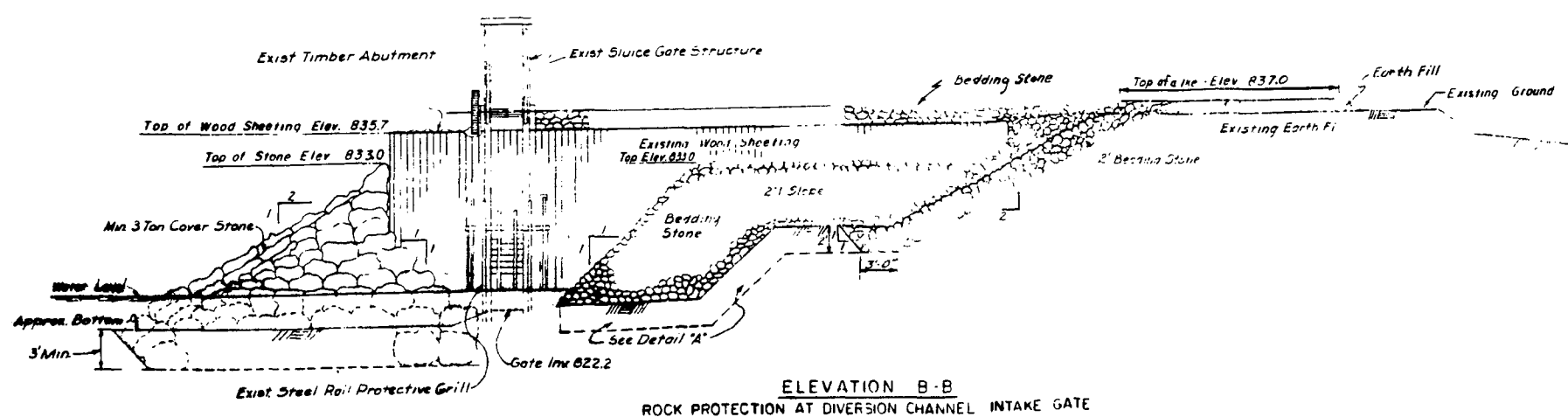
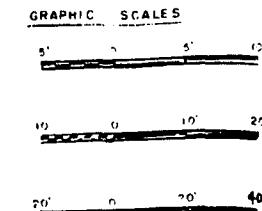
General Plans and Sections
Dated June 1960

Plate 2



AS BUILT

- NOTES:
- Elevations refer to Mean Sea Level Datum.
 - Contour interval is 2 feet.
 - Top of 3 ton cover stone placed along timber face of abutment shall be one to three feet below the top of the existing timber sheeting except as shown.
 - Offsets to center line of Flank Dike are at right angles to baseline.
 - All offsets to Dike are at right angles to the baseline and are measured to the toe face of the top stone.
 - Excavations for toe embedment of cover stone and bedding stone shall be carried to the depths indicated or to top of rock ledge if rock ledge is encountered.



Local Protection Project (LPP)
Lincoln, New Hampshire
East Branch, Pemigewasset River

Detail Plan and Sections
Dated June 1960

Plate 3

5. Project Integrity:

Although the Lincoln LPP has performed its intended purpose to date, the ability of the LPP to provide the original design level of flood protection has been reduced slightly. This reduction in the LPP's level of protection is based on present estimated discharge frequencies obtained from a recently updated hydraulic analysis. According to town officials, the Lincoln LPP project has provided adequate protection to all of the structures (i.e., hotels, condominiums, shopping plazas, restaurants) in the protected area. Town officials could not recall any flooding problems in the protected area, since its completion in 1960. According to the town planner, developers who own the land adjacent to the project have not expressed any concerns about flooding problems and have not viewed the flooding threat as large enough to affect their plans.

The town planning board, which has been in existence for six years, oversees development and requires that all new development be built above the 100 year floodplain. Although the town does not participate in the National Flood Insurance Program (NFIP), all development which has occurred in the area for the last six years has been regulated by the planning board. This has ensured that development is built above the 100 year floodplain. The town does not participate in the NFIP by vote of the town. The town manager cited that since the National Forest Service controls 94% of the land area in town, the town wants to retain full control over the remaining land. Based on the above information, it appears that the existing LPP provides adequate protection to the area.

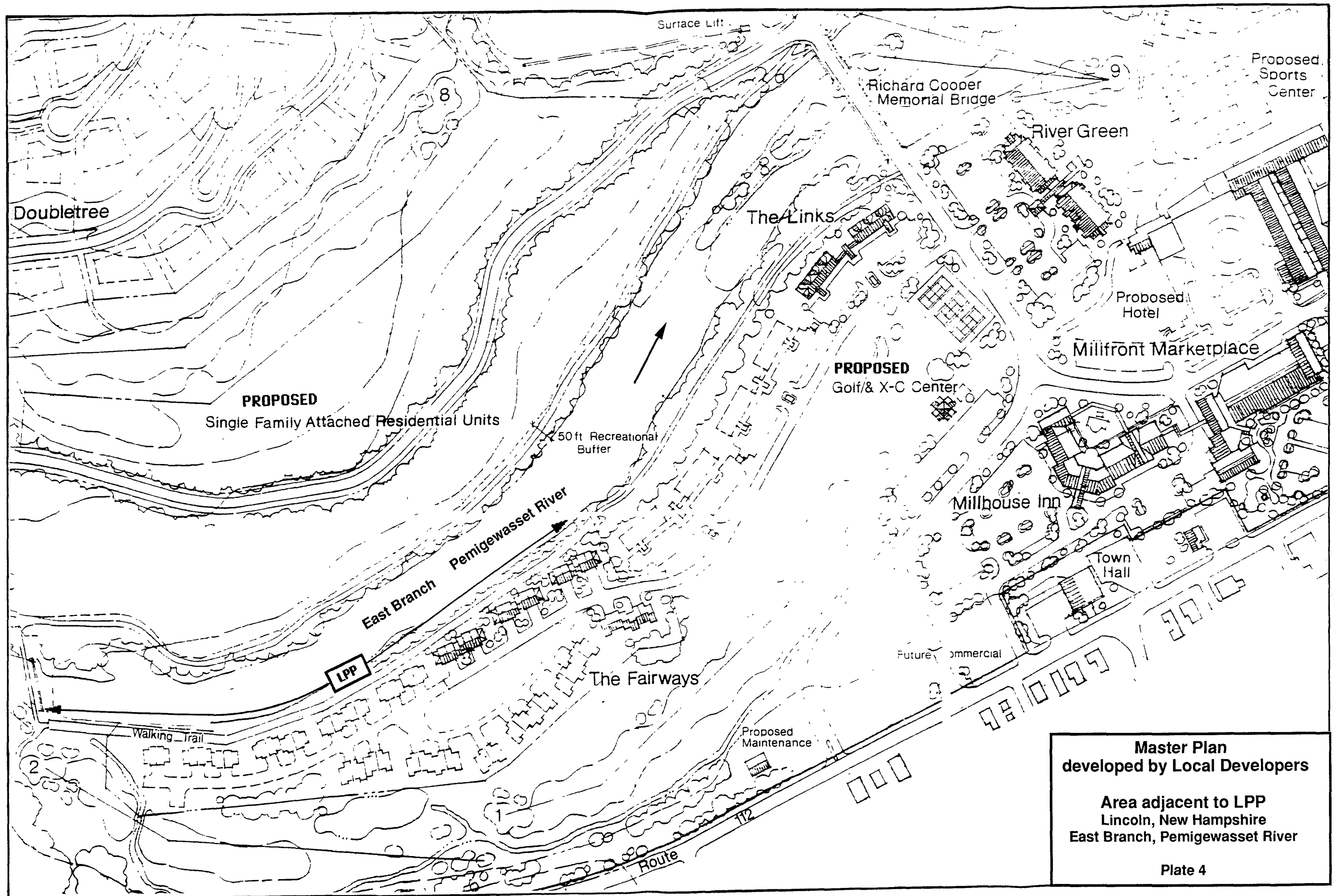
The Lincoln LPP, completed in 1960, was designed to provide a minimum of 3 ft. of freeboard above a river discharge of 24,200 cfs. A flow of 24,200 cfs was originally estimated to be about a 100-year(1% chance) annual flood event. Under the present estimated discharge frequencies, the LPP provides a minimum of 3 ft. of freeboard above a 1 to 2 percent (75-year) annual chance flood event.

III. FUTURE CONDITIONS

Flood Plain Development:

Projected Future Land Use:

Private developers own the land surrounding the LPP and the former mill site on both sides of the East Branch of the Pemigewassett River. The developers have created a master plan for the area which includes several major expansion changes in land use for the area surrounding the LPP. (See Plate 4.) The most significant element of the plan, having the greatest impact on the area, is the proposed expansion of the Loon Mountain ski area. This expansion includes developing a new face of Loon Mountain with ski trails descending to a new base lodge across the river from downtown Lincoln. In addition, more condominium units for the Fairways project, as well as several other proposed condominium projects, are part of the master plan. All of these plans will greatly increase the number of condominium units in the area. For the land immediately adjacent to the river in the vicinity of the old mill, a nine hole golf course is planned.



1. Community Plans:

The degree to which the above plans will be implemented and the speed at which they will be implemented is unknown at this time. Currently, the condominium market in Lincoln appears to be saturated. There are many new, unsold units on the market. The weakness in the real estate market has postponed the completion of the one project.

It is likely that the construction of the other condominium projects in the master plan will also be delayed. It is not known when the construction of the golf course or the expansion of Loon Mountain will begin, or when they will be completed.

2. Economics:

The flood damages prevented by the LPP calculated in 1960 were based on a flood damage survey of the paper mill. Total damages prevented by the project to date are not available because the Corps has not conducted a flood damage survey of the existing structures built in the project area since the paper mill closed in the early 1970's.

IV. CURRENT PLANNING & DESIGN CRITERIA

A. Freeboard

1. Requirements: There are no specified criteria with regard to the design level of protection for flood damage reduction projects. Each project should be complete-within-itself and provide the maximum net benefits, unless there is overwhelming justification to deviate. In rural areas the flood of record is a design goal since potential overtopping or failure could be reasonably expected.

The freeboard of a channel is the vertical distance measured from the design water surface to the top of the channel wall or levee. Freeboard is provided to ensure that the desired degree of protection will not be reduced by unaccounted factors. Engineering regulations call for freeboard allowances above design grade of 3 ft for earth dike or levee systems.

2. Economics: EM 1120-2-104 outlines the procedure regarding benefits for advance replacement of existing projects. A credit can be taken when extending the life of a project and realizing benefits beyond which the project would have continued to function. Since the Lincoln LPP is over 30 years old and is at the mid-point of its economic life, any modification that extends its physical life may take advance replacement benefits. However, an engineering analysis of the structure's stability and integrity would have to be accomplished to determine just how much longer the LPP can perform its intended purpose since advance replacement benefits can only be attributed for the period of time after that.

V. MODIFICATION OPPORTUNITIES

A. Level of Protection:

Opportunities to increase the level of protection of the Lincoln LPP are limited. Changes in land use of the project area, combined with changes in the known hydrologic conditions since the project was designed (15% increase in discharge), have increased the uncertainty as to the level of protection provided by the project. The LPP originally protected a paper mill. Today it protects retail and residential structures. Retail and residential structures typically yield lower average annual damages than industrial or manufacturing structures. Thus it is unlikely that increasing the level of protection to the project area would be economically feasible.

B. Protected Area:

Inspection of the areas downstream and upstream of the existing LPP indicates that an extension of the flood protection is not needed at this time. In addition, the community's lack of concern in regards to flooding demonstrates that extension of the LPP is probably not required at the present.

C. Project Features:

Items noted as being deficient in the recent inspection should be attended to for assurance of project purpose.

VI. CONCLUSIONS

The LPP is in satisfactory condition and is expected to continue to perform its intended purpose with adherence to proper operational and maintenance procedures. It is currently capable of providing protection against an event having an annual chance of occurrence slightly greater than 1 to 2 percent, or one having a recurrence interval of just over 50 years. There is about 2.5 feet of freeboard above the design level of protection the October 1959 flood of record. Although the LPP no longer protects the former paper mill, it still provides flood protection for new land uses. At the present time, no additional modifications to the Lincoln LPP are necessary.

VII. RECOMMENDATIONS

Modifications to increase the level or extent of the flood protection at the Lincoln LPP are not recommended at this time. Based upon visual observations and discussions with town officials, the LPP is providing adequate protection and will continue to do so in the near future. However, due to the project's age another review should be scheduled. The LPP will be 40 years old in 2000. This would be an appropriate time for the next review.

APPENDIX A: HYDRAULIC AND HYDROLOGIC ANALYSIS

LINCOLN LOCAL PROTECTION PROJECT
LINCOLN, NEW HAMPSHIRE
HYDROLOGIC ASSESSMENT

BY
HYDROLOGIC ENGINEERING BRANCH
WATER CONTROL DIVISION
DIRECTORATE OF ENGINEERING

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

MAY 1990

LINCOLN LOCAL PROTECTION PROJECT
LINCOLN, NEW HAMPSHIRE
HYDROLOGIC ASSESSMENT

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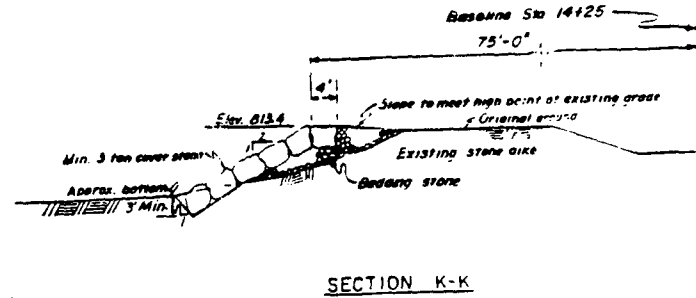
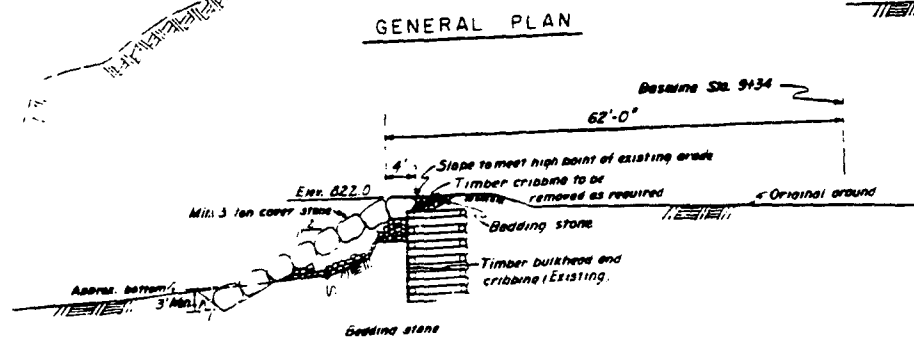
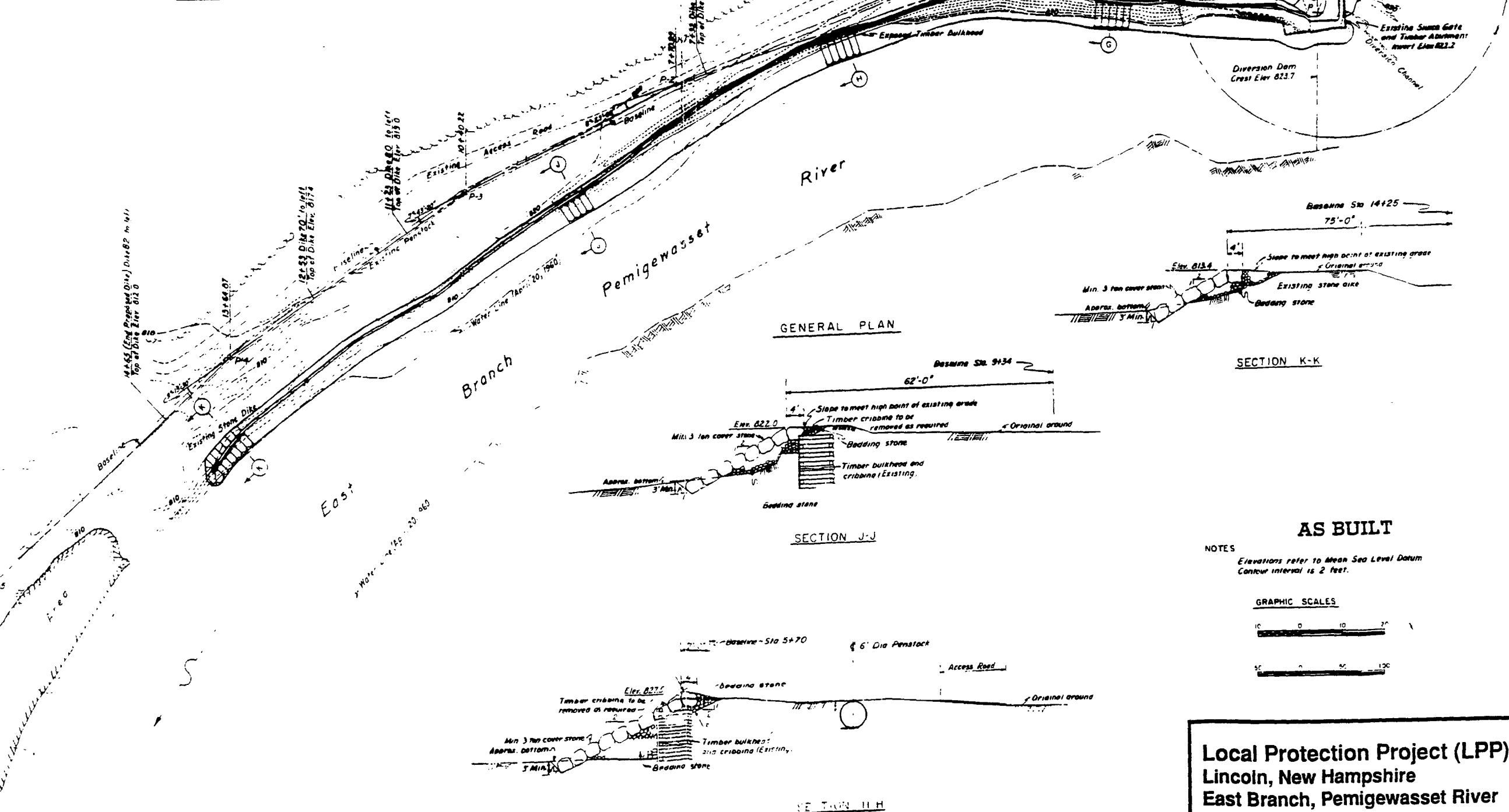
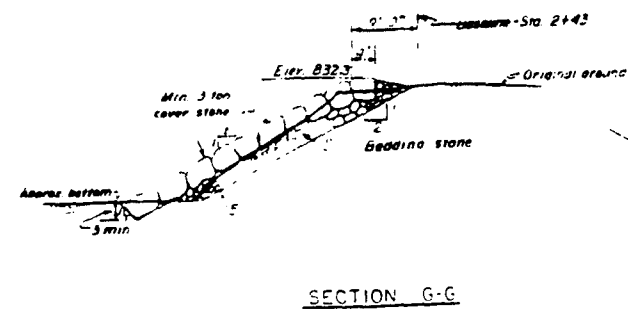
LINCOLN LOCAL PROTECTION PROJECT
LINCOLN, NEW HAMPSHIRE
HYDROLOGIC ASSESSMENT

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3	Peak Discharge-Frequency Curves Woodstock and Lincoln, New Hampshire
4	Rating Curves, Lincoln, New Hampshire
5	Stage-Frequency Curves Lincoln, New Hampshire



AS BUILT

NOTES
Elevations refer to Mean Sea Level Datum
Contour interval is 2 feet.

GRAPHIC SCALES
1" = 10' 0" 10' 20' 30'
1" = 100' 0" 100' 200' 300'

Local Protection Project (LPP)
Lincoln, New Hampshire
East Branch, Pemigewasset River

General Plans and Sections
Dated June 1960

Plate 1

times from 1929-1953 and 1968-1972. In addition, based on the field observations and original survey information in design documents, a stage-discharge rating curve was developed by inserting river cross sections to the HEC-2 backwater program and computing flood profiles for various discharges. This rating curve, shown on plate 4, compared well in terms of relative stages with that established at the USGS station. Applying this rating curve and both the original project design and present estimate of discharge frequencies, comparative stage frequencies were developed for this location and are shown on plate 5.

6. LEVEL OF PROTECTION

The project dike completed in 1960 with a top elevation varying from 836 feet NGVD at diversion dam to 823 feet NGVD, 900 feet downstream, was designed to provide a minimum of 3 feet of freeboard above a river discharge of 24,200 cfs. A flow of 24,200 cfs was originally estimated to have about one percent (100-year) annual chance of occurrence. Under the present estimated discharge frequencies, the dike provides a minimum of 3 feet of freeboard above a 1 to 2 percent (75-year) annual chance of occurrence. Due to increases in discharge frequencies, the present level of protection is slightly lower than that provided for in the original project design.

7. RECOMMENDATIONS

It is recommended that the stage frequency and level of protection information, herein, be used only for initial appraisal of average annual benefits in the area to determine whether any increase of the height of the dike would be economically feasible. Our field inspection in March 1990 observed that the vegetation and tree growth on the dike had been removed since last COE inspection in 1989. In so far as debris accumulation in the channel, it was not observed during the field inspection. If further study is required, it is recommended that detailed river surveys be obtained to accurately establish current top-of-dike elevations and channel cross sections. This information would permit a more accurate determination of current project hydraulic capacity.

4. DISCHARGE FREQUENCIES

a. Original Project Design. The discharge-frequency curve for the Lincoln gaging station used for project design was calculated by Beard's method from a 24 years-of-flow-record. The mean and standard deviations were adjusted by correlating with the long-term record on Pemigewasset River at Plymouth, NH. The adjusted statistics had a reliability equivalent to 42 years of record. A skew of 0.6 was adopted on the basis of regional studies. The resulting 1959 curves are shown on plate 2.

b. Present Condition. The Lincoln gaging station has a continuous record from 1929-1953 and 1968-1972 plus an estimated discharge for the October 1959 flood of record. These 30 years of record were analyzed in a Log Pearson Type III distribution in accordance with procedures presented in WRC Bulletin 17B. This curve was also correlated with the long-term Plymouth-gaged record to adjust the mean and standard deviation in accordance with procedures in WRC Bulletin 17B. This analysis resulted in 44 years of equivalent record and an adjusted mean log of 3.682, standard deviation of 0.285 and a skew of 0.6 was adopted based on regional studies.

The resulting peak discharge frequencies as shown on plate 2 are about 15 percent greater in discharges than the original design studies in the 1 to 2 percent chance range. This is mainly attributed to an increase in discharge frequencies at the long-term Plymouth gage.

Peak discharge frequencies were also developed for the Pemigewasset River by analysis of records from the discontinued gaging station at Woodstock, NH downstream of Lincoln. USGS gaging station 01075000 at Woodstock has a drainage area of 193 square miles and a period of record of 39 years (1940-1979). The peak discharges were analyzed in a Log Pearson Type III distribution in accordance with the guidelines in WRC Bulletin 17B and the discharge-frequency curve shown on plate 3 was computed using an adopted skew of 0.5. The resulting discharge frequencies at Woodstock were then transferred to Lincoln by ratio of drainage areas to the 0.7 power. This compared well with the present updated peak discharge frequencies shown on plate 2 at Lincoln.

5. STAGE FREQUENCY

There is no current FEMA Flood Insurance Study flood profile information available on the East Branch of the Pemigewasset River in Lincoln. However, two miles upstream of the project, the USGS gaging station had a discharge-rating relationship established for recorded floods at various

TABLE 1

EAST BRANCH PEMIGEWASSET RIVER
LINCOLN, NEW HAMPSHIRE

<u>Flood</u>	<u>Peak Discharge</u>		
	Lincoln DA=109 s.m. 1929-1953 1968-1972 <hr/> (cfs)	Woodstock DA=193 s.m. 1940-1979 <hr/> (cfs)	Plymouth DA=622 s.m. 1904-1988 <hr/> (cfs)
November 1927	unknown	unknown	60,000
3 May 1929	9,800	" "	22,900
19 March 1936	17,000	" "	65,400
21 September 1938	16,300	" "	50,900
3 May 1940	9,100	15,500	25,400
9 November 1944	10,300	17,600	29,300
26 November 1951	14,700	22,800	28,300
1 June 1952	10,600	18,400	27,400
24 October 1959	24,200 (est.)	47,000	52,700
30 June 1973	unknown	29,500	47,600
1 April 1987	unknown	unknown	53,200

LINCOLN LOCAL PROTECTION PROJECT
LINCOLN, NEW HAMPSHIRE
HYDROLOGIC ASSESSMENT

1. PURPOSE

This report presents a cursory hydrologic review of the Lincoln Local Protection Project at Lincoln, New Hampshire. The review was performed as part of an overall project assessment by Planning Directorate. Included are sections on project description, history of floods, flood frequencies, stage frequencies, level of protection, and recommendations for further studies.

2. PROJECT DESCRIPTION

The Lincoln Local Protection Project was designed under Public Law 99 and completed in 1960 to restore an existing timber crib flood control dike that was damaged during the October 23-25, 1959 flood. The project, with drainage area of 109 square miles, and adopted design flow of 24,200 cfs, consists of:

a. Placement of a 3 foot single layer of cover stone, minimum 3-ton laid on the existing dike. The existing dike is composed of a 1,350 feet long rock-filled timber crib, as shown on plate 1.

b. A flank dike 230 feet in length, runs north from the west abutment of the upstream diversion dam to high ground.

c. Channel excavation by the removal of stone and boulders in the reach of the existing dike.

3. HISTORY OF FLOODS

The East Branch of the Pemigewasset River has experienced eleven significant floods in the last 60 years, a summary of which is shown in table 1. The two largest floods occurred in October 1959 and November 1927. The flood of 24 October 1959 was estimated by the USGS to have had an instantaneous peak of 24,200 cfs at the diversion dam located upstream of the project area. The peak discharge during the flood of November 1927 is unknown but is reported by local residents to have been the largest flood prior to October 1959. Hydrologic analysis during design studies of the two floods in the upper Pemigewasset River indicated that the peak flow on the East Branch during the October flood was probably slightly in excess of that during the November 1927 flood. No overtopping of the dike has been reported since the construction of the project.

PLATE 2

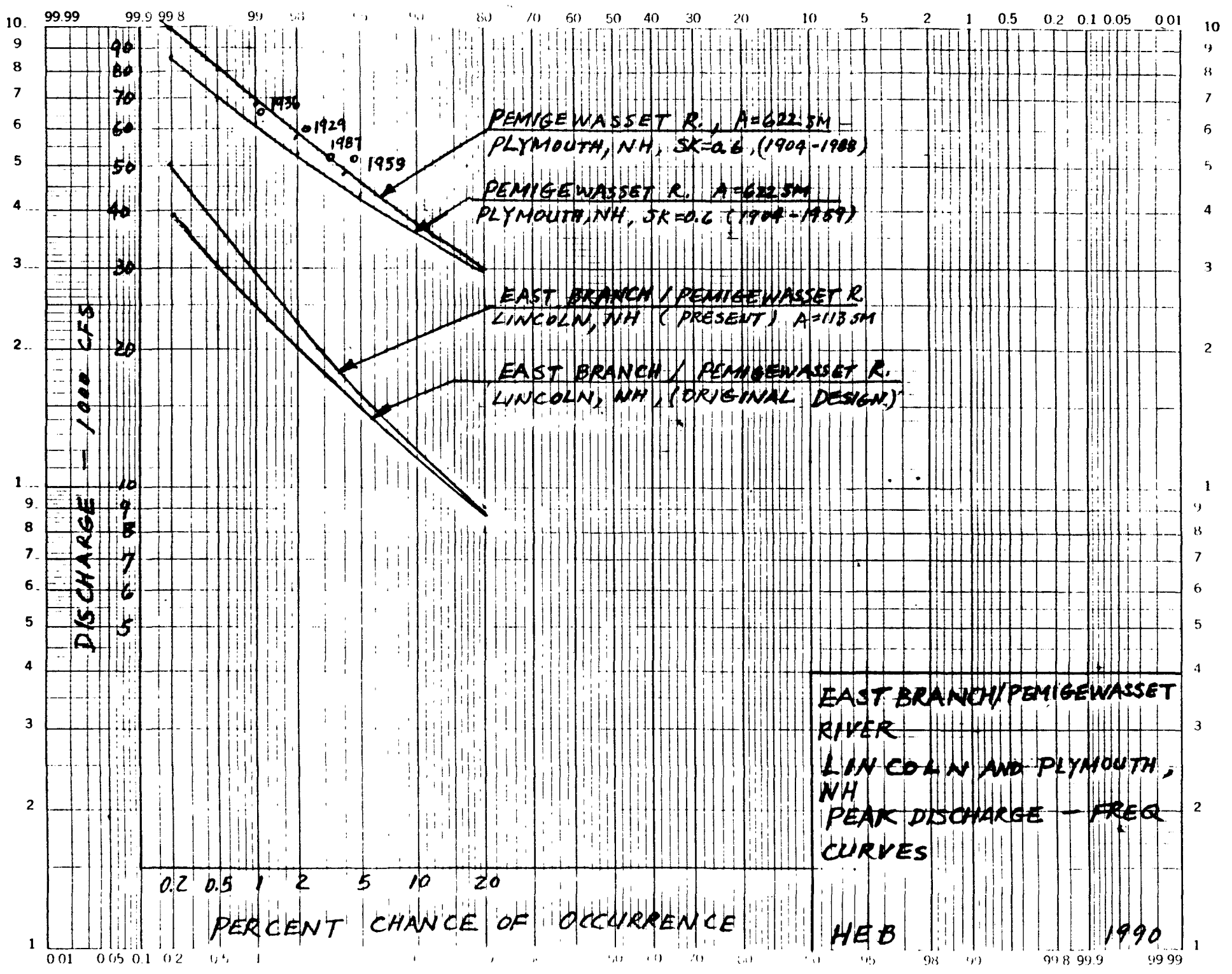
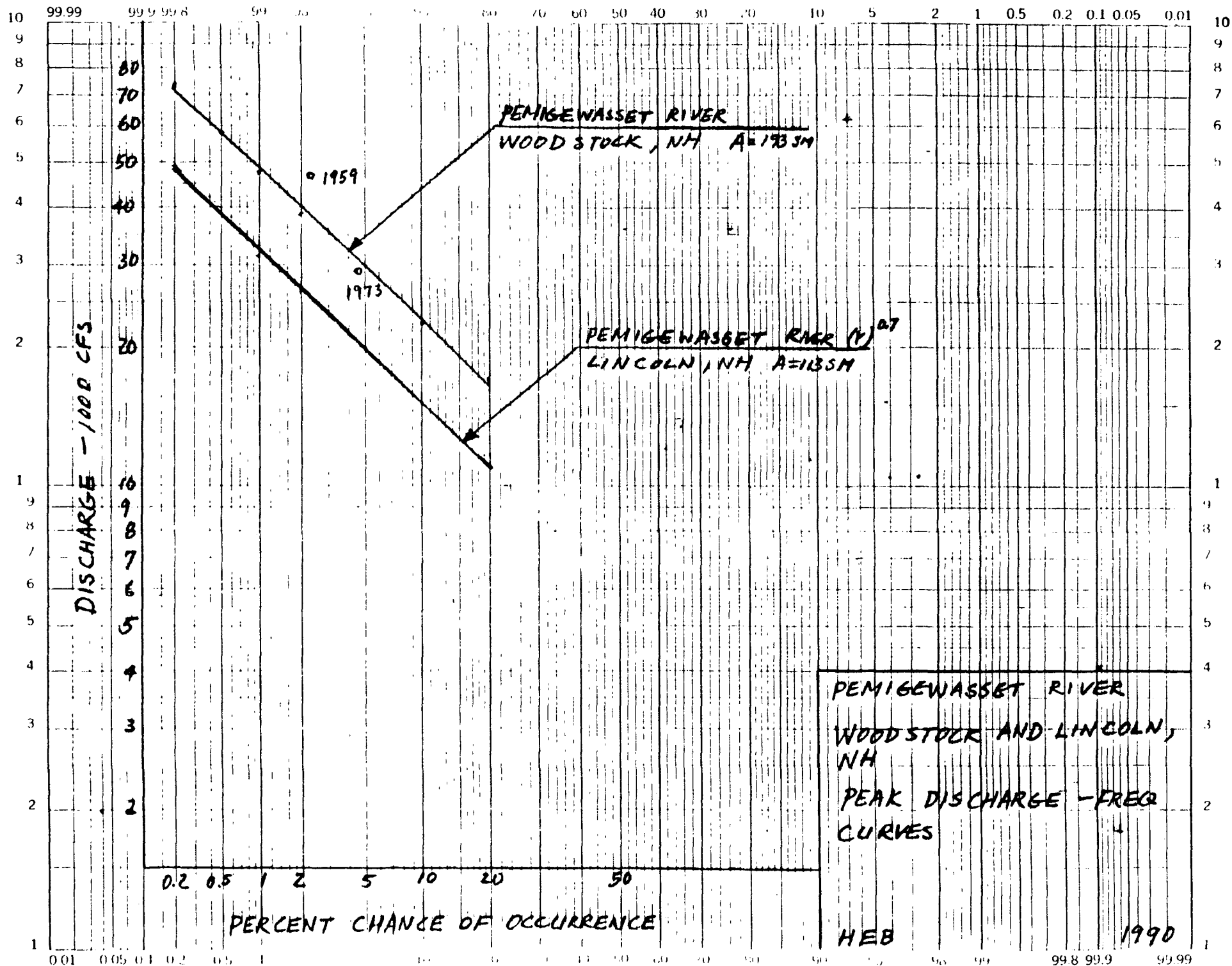


PLATE 3



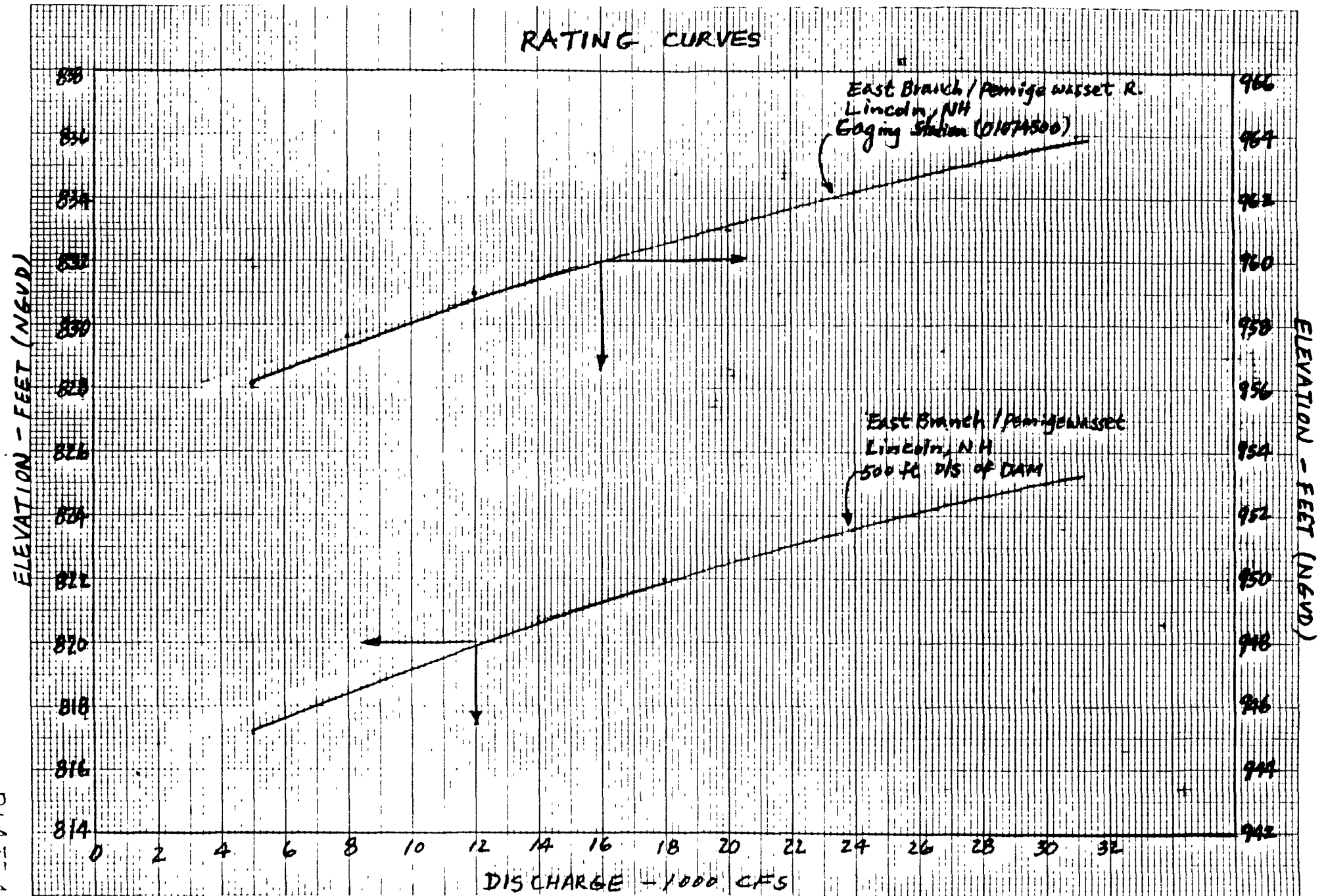




Plate 5

APPENDIX B: PERTINENT CORRESPONDENCE

27 June 1990

Operations Directorate
Project Operations Division

Mr. Edmond Gionet
Chairman
Board of Selectmen
Lincoln, New Hampshire 03251

Dear Mr. Gionet:

My representatives conducted the annual inspection of the federally built local flood protection project in Lincoln on May 22, 1990. I have enclosed a detailed inspection report for your review.

The project is in good condition. I am pleased to learn that most of the vegetation has been cleared off the dikes. Your maintenance staff should be commended for their efforts.

An Initial Eligibility Inspection to assess the overall condition of the LPP was conducted simultaneously with the annual inspection of the project. A detailed report of the Initial Eligibility Inspection findings will be forwarded to you under separate cover.

Please thank Mr. Dauphine for his cooperation during the inspection. If you require any technical assistance in the operation and maintenance of your project, please call me at (617) 647-8411 or Mr. Jim Ward, Basin Manager, Merrimack River Basin, at (603) 934-2673.

LAW

ROSATO

B. C. Manor

Chief, Project Operations Division

MANOR

LOCAL FLOOD PROTECTION PROJECT INSPECTION REPORT

Project: Lincoln, NH

Maintaining Agency: Town of Lincoln, NH

Type Inspection: ☒ ~~Semi~~-Annual Staff ☐ 90 Day Interim

River Basin: Merrimack River Basin

Date of Inspection May 22, 1990

Feature	Sat	Unsat	Deficiencies
PUMPING STATIONS - STRUCTURES N/A			
INTERIOR			
EXTERIOR			
PUMPS - MOTORS - ENGINES N/A			
TRIAL OPERATED			
GENERAL CONDITION			
POWER SOURCE			
INSULATION TESTS			
METAL INTAKES/OUTLETS			
GATE VALVES			
GATES - DRAINAGE STRUCTURES N/A			
TRIAL OPERATED			
GENERAL CONDITION			
LUBRICATION			
DIKES - DAMS			
GENERAL CONDITION	X		
SLOPES/EROSION	X		
SAND BOILS/CAVING	X		
TRESPASSING	X		
SLOPE PROTECTION	X		
DRAINS			
STOP-LOGS - LOG BOOM N/A			
CONDITION OF LOGS			
AVAILABILITY OF LOGS			
HIGHWAY SLOTS			
STORAGE FACILITIES			
CHANNELS - OUTLET WORKS CHANNEL			
BANKS	X		
OBSTRUCTION CONTROL	X		

Feature	Sat	Unsat	Deficiencies
CONCRETE STRUCTURES N/A			
SURFACE			
SETTLEMENT			
JOINTS			
DRAINS			
MISCELLANEOUS			
EMERGENCY OPER. PLAN			
EMERGENCY EQUIPMENT			
SEMI-ANNUAL REPORT			

Inspection Party:

Mr. Clifton Dauphine - Town of Lincoln
 Mr. O. J. Laroche, Project Manager, Franklin Falls Dam
 Mr. Jim Ward, Basin Manager, MRB
 Mr. Yuri Yatsevitch, Corps of Engineers, Engineering Division
 Mr. John Yen, Corps of Engineers, Engineering Division
 Mr. Jim Law, Corps of Engineers, Operations Division

Photographs Taken:

None

Remarks & Additional Comments:

(Indicate Here Observations, Discussions, Specific Feature Deficiencies, Recommendations and any other pertinent information. Use Continuation Sheet if necessary.)

The embankment was recently cut and is now in good condition.

X ALL APPLICABLE ITEMS. IF UNSAT INDICATE SPECIFIC DEFICIENCIES. INDICATE IF NOT APPLICABLE.

DATE	INSPECTED BY: TYPED NAME & TITLE	SIGNATURE
		

April 24, 1989

Operations Division,
Project Operations Branch

Mr. Edmund Gionet
Chairman
Board of Selectmen
Lincoln, New Hampshire 03251

Dear Mr. Gionet:

My representatives conducted the annual inspection of the federally built local flood protection project in Lincoln on April 20, 1989. I have enclosed a detailed inspection report for your review.

The project is in satisfactory condition, capable of fulfilling its intended purpose. Annual brush cutting is still needed each year.

I want to thank Mr. Dauphine for his cooperation during the inspection. If you require any technical assistance in the operation and maintenance of your project, please call me at (617) 647-8411 or Mr. Jim Ward, Merrimack River Basin Manager at (603) 934-2673.

Sincerely,

B. C. Manor
Chief, Project Operations Branch

Enclosure

Copies Furnished:

Mr. Delbert Downing
Chairman, Water Res. Board
State of New Hampshire
P. O. Box 2008
Concord, NH 03301

Mr. Clifton Dauphine
Maint. Superintendent
Main Street
P. O. Box 25
Lincoln, NH 03251

Miss Kaleen Roberts
Admin. Asst. to Selectmen
Board of Selectmen
Lincoln, NH 03251

BM, MRB
PM, Franklin Falls
Opers. Div. Files

LOCAL FLOOD PROTECTION PROJECT INSPECTION REPORT

Project: LINCOLN, NH

Maintaining Agency: TOWN OF LINCOLN, NH

Type Inspection: ☒ ~~Semi~~-Annual Staff ☐ 90 Day Interim

River Basin: Merrimack

Date of Inspection 20 April 1989

Feature	Sat	Unsat	Deficiencies
PUMPING STATIONS - STRUCTURES N/A			
INTERIOR			
EXTERIOR			
PUMPS - MOTORS - ENGINES N/A			
TRIAL OPERATED			
GENERAL CONDITION			
POWER SOURCE			
INSULATION TESTS			
METAL INTAKES/OUTLETS			
GATE VALVES			
GATES - DRAINAGE STRUCTURES N/A			
TRIAL OPERATED			
GENERAL CONDITION			
LUBRICATION			
DIKES - DAMS			
GENERAL CONDITION	X		See Comment #1
SLOPES/EROSION	X		
SAND BOILS/CAVING	X		
TRESPASSING	X		
SLOPE PROTECTION	X		
DRAINS			
STOP-LOGS - LOG BOOM N/A			
CONDITION OF LOGS			
AVAILABILITY OF LOGS			
HIGHWAY SLOTS			
STORAGE FACILITIES			
CHANNELS - OUTLET WORKS CHANNEL N/A			
BANKS			
OBSTRUCTION CONTROL			

Feature	Sat	Unsat	Deficiencies
CONCRETE STRUCTURES			
			N/A
SURFACE			
SETTLEMENT			
JOINTS			
DRAINS			
MISCELLANEOUS			
EMERGENCY OPER. PLAN			
EMERGENCY EQUIPMENT			
SEMI-ANNUAL REPORT			

Inspection Party:

Mr. Clifton Dauphine, Superintendent of Maint., Town of Lincoln

Mr. O.J. Laroche, Project Manager, Franklin Falls Dam

Photographs Taken:

Yes

Remarks & Additional Comments:

(Indicate Here Observations, Discussions, Specific Feature Deficiencies, Recommendations and any other pertinent information. Use Continuation Sheet if necessary.)

Comment #1 - Vegetation needs to be removed before the next inspection.

X ALL APPLICABLE ITEMS. IF UNSAT INDICATE SPECIFIC DEFICIENCIES. INDICATE IF NOT APPLICABLE.

DATE 21 April 89	INSPECTED BY: TYPED NAME & TITLE O.J. Laroche, Project Manager	SIGNATURE <i>O.J. Laroche</i>
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